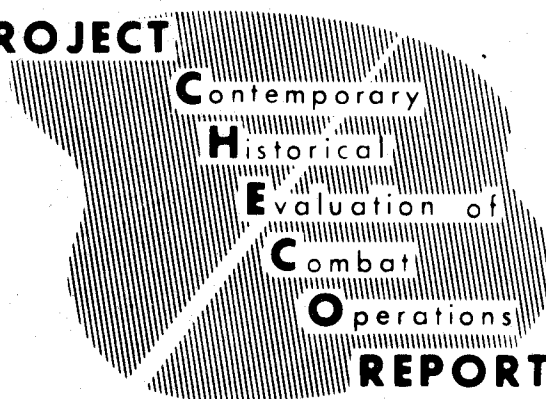


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**AIR TACTICS**  
**against**  
**NVN AIR/GROUND DEFENSES**

**27 February 1967**

**HQ PACAF**  
**Directorate, Tactical Evaluation**  
**CHECO Division**

**Prepared by: Capt. Melvin F. Porter**

**S.E. Asia Team**

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*Edward C. Burtenshaw*

EDWARD C. BURTENSHAW, Col, USAF  
Chief, CHECO Division  
Directorate, Tactical Evaluation

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FOREWORD

The following report records the dynamic development of air tactics against the progressively formidable NVN air and ground defenses during the period 5 August 1964 (Gulf of Tonkin Incident) to November 1966.

Previously, this air action has been recorded under the title of ROLLING THUNDER, which had been intended as a continuing report. Due to the multi-faceted nature of air operations in the Southeast Asian area, the CHECO reports lend themselves best to specific studies within the broad operational concepts of area reports such as ROLLING THUNDER, TALLY HO, STEEL TIGER, etc., hence the change of title. The monthly analysis of ROLLING THUNDER operations will continue to be reported in Summary Air Operations Southeast Asia, published by this Directorate.

As a record of events and occurrences leading to the current tactical situation, it is hoped this report will contribute significantly to an understanding and appreciation of the tasks faced by combat air-crews over North Vietnam as well as to give the reader a narrative basis for evaluation of these operations.

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AIR TACTICS AGAINST NVN AIR/GROUND DEFENSES

I. INTRODUCTION

The first U.S. aircraft lost to North Vietnam defenses were downed during the retaliatory strikes flown by the Navy on 5 August 1964 against PT boat facilities along the NVN coast, following the Gulf of Tonkin incident. Two aircraft were brought down by AW/AAA (automatic weapons and anti-aircraft artillery). One pilot was captured; the other was listed as missing.

These aircraft were lost to an unsophisticated defense environment; quite simply, intense ground fire. Enemy aircraft were not a factor. Surface to air missiles had not yet made an appearance. Following that event North Vietnamese air and ground defenses evolved into a smooth working, integrated, formidable system encompassing the flight envelope from the ground up, with remarkably few gaps. Our combat tactics had to evolve with them for survival and for mission accomplishment, and the evolution at times was painful and costly. <sup>1/</sup>

For an extended period from the summer of 1965 through early autumn of 1966, the situation facing strike pilots over North Vietnam was indeed grim. The outlook improved with the addition of new equipment and tactics in late 1966.

At the beginning of the Flaming Dart/Rolling Thunder programs (Feb-Mar, 1965) AW/AAA defenses were, to all intents and purposes, all

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that strike pilots going north had to face. The North Vietnamese AAOB (Anti-Aircraft Artillery Order of Battle) on 8 February 1965 was estimated <sup>2/</sup> by the PACAF Director of Intelligence to be:

<u>MED GUNS</u>	<u>(POSS)</u>	<u>LIGHT GUNS</u>	<u>(POSS)</u>	<u>AW GUNS</u>	<u>(POSS)</u>	<u>TOTAL GUNS</u>	<u>(POSS)</u>
862	(1057)	252	(460)	286	(561)	1426	(2113)

Since the effective altitude limits of many of these weapons were below 5,000 feet, pilots had little difficulty in locating and using permissive flight envelopes. Only during the strikes themselves, when dictates of accuracy made descent into the lethal range of these weapons necessary, were hits taken with any regularity.

Considering the North Vietnam air capability, they had a MIG 15/17 force trained and in place prior to the beginning of continuing U.S. air strikes. (Introduced into NVN in Aug, 1964.) Their Air Order of Battle (AOB), however, consisted of approximately only 36 of these aircraft, and Hanoi had shown a marked reluctance to commit their jet fighter force to anything other than defensive patrols of the Hanoi area. <sup>3/</sup>

At this point, American fighter and fighter bomber tactics were relatively as unsophisticated as the defenses they were up against.

## II. THE MIG THREAT

On 4 April, 1965, the MIG's made their first attack as indicated <sup>4/</sup> in the mission report below:

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"...ZINC lead started a left turn at this time. We were at 15,000 feet and 325 KCAS...STEEL 01 called out that MIG's were in the area and told everyone to 'keep their heads up'.

"We had completed nearly 180 degrees of turn and were passing through a heading of 200 degrees...at this time I saw four aircraft coming in from behind us out of a 20 degree dive. They were approximately 3000-4000 feet behind the flight. The lead element was set up in an attacking position for ZINC lead's element, while the second element, further behind, was in position for an attack on my element. I called ZINC lead and said: 'ZINC lead--BREAK--you have MIGS behind you---ZINC lead---BREAK---ZINC lead, we're being attacked.' At this same time, my wingman and I broke into the attack, jettisoned external stores, went to afterburner, and lowered the nose to pick up airspeed. Neither ZINC lead or 02 reacted in any way to these calls (the calls were heard and understood by other mission aircraft). ZINC 04, my wingman, also made several calls telling lead to break.

"...It was at this time that I clearly saw and identified the aircrafts as MIG-17's. They were grayish in color and the markings on the bottom of their wings were clearly visible. It was a red star with a red bar coming out of either side of the star. I saw the leader's guns flashing about 1500 feet behind ZINC lead and I saw several hits in the aft section of his aircraft. The second MIG fired at ZINC 02 almost simultaneously. I saw numerous flashes on the aft part of ZINC 02's aircraft, which appeared to be hit more severely (no flashes were made by the hits on ZINC lead's aircraft). An instant prior to this, ZINC 02 had called ZINC lead and said: 'Lead, you have MIG behind you (pause) I've been hit'."

Both Zinc lead and Zinc 02 were lost to the MIG cannon fire in this engagement. (Zinc 03 made a sudden break and caused the second element of MIG's to overshoot him. They continued straight ahead and broke off the fight.) Subsequent to the first engagement, Zinc 03 was attacked by another pair of MIG's a few moments later. After noting "flashes" going by him on his right, he evaded the attacking aircraft: 6/

"...I had already come out of afterburner a few moments

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before, thinking that the initial attacking aircraft were the only ones in that immediate area. My speed was about .84 Mach and I was about 10,000 feet at this time. I rolled the aircraft under and reversed my turn. This seemed to displace the MIG's somewhat, but not very much. I started to climb to gain some altitude, making a few turns as I went up to try to keep the MIG's in sight. They were slowly gaining on me now and seemed to be about ready to get in a good firing position. I knew that I would have to do something drastic to shake them. I pulled the nose up a little more and rolled the aircraft over to the left as if I were starting a 'Split S'. I could see that they were also rolling to stay with me. I pulled the nose down and started a corkscrewing turn downwards to the left. I pulled the power to idle in the turn and when I had completed nearly three-quarters of a turn, I pulled the stick back sharply. The nose came up rapidly and the aircraft burbled. Suddenly, below and to my right, I saw both MIG's sliding outside and forward of me. I lowered the nose and went to maximum power as I only had about 250 KCSA. I was at 4000 feet at this time and had to slowly ease the nose up to avoid mushing into the ground. I estimated I cleared the ground by 500-1000 feet. The MIG's started pulling away from me as I could not build up my speed fast enough with this little altitude for recovery. I lost sight of them in the haze and low scud that was in the area."

abw  
This pilot forwarded several recommendations regarding tactics and procedures in the conduct of missions over North Vietnam, among which were the necessity for practicing and understanding tactics which could be used successfully against Soviet bloc aircraft. <sup>1/</sup> He stressed the need for keeping the airspeed high enough to permit a degree of maneuverability (and acceleration) in case of attack.

cm  
The aircraft in Zinc flight were USAF F-105 Thunderchiefs, which suggested in many performance parameters when compared to the MIG-17. This was not the case with the F4C. The Phantom enjoyed performance superiority over the MIG-17 in all respects except low-Mach, high-G

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turns. On 10 July, 1965, Captains Kenneth E. Holcomb and Thomas C. Roberts of the 45th Tactical Fighter Squadron were aircraft commanders of Mink 3 and 4 in a flight of four F4C's. <sup>8/</sup> This flight was in a loose tactical formation while flying MIGCAP, about 50 nautical miles west of Hanoi, at the time bogies were picked up on their AI (airborne intercept radar). Lead and Mink 1 accelerated out ahead to perform a visual identification on the bogies and, as they passed abeam and slightly below the two strange jets, positively identified them as MIG-17's. The MIG's immediately jettisoned their tanks and turned into Lead and Mink 1, which actually put them into a favorable position on Mink 3 and 4 who were trailing the lead element by only a mile. The MIG's began firing their cannons at a high angle off, but missed, and Mink 3 and 4 punched off their tanks and broke into them. During the break the two F4C's became separated, with the MIG's following suit and splitting to follow each one.

Mink 4 immediately "unloaded" (pushed the stick forward to remove all G's, or wing-loading) and went into afterburner to accelerate to approximately Mach 1.2. He then pulled up into a steep climb with the MIG behind him. As he got to the top he saw the trailing MIG begin to "fall out of the sky"; Mink 4 executed a wing-over and a 180° turn to put himself on the enemy's tail. He fired four AIM-9B Sidewinder missiles and destroyed the MIG.

Mink 3 attempted to out-turn and out-maneuver the MIG following him, with neither one gaining much of an advantage. When he realized

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this game was getting him nowhere, he followed much the same tactic as Mink 4, ending up on the tail of the MIG and shooting him down with Sidewinders.

This was the first conclusive aerial combat exposure in the F4C, and from it valuable lessons were learned. <sup>9/</sup> Once again, turning with the MIG appeared to be playing "his game". The deciding maneuver in both cases was the zero G - accelerate to plus Mach - zoom-climb sequence. This put the F4C into the most favorable part of his performance envelope, while at the same time reducing the MIG performance to almost nil. It brought out a combat tactics "truth" which was to be heavily emphasized in subsequent ACT (air combat tactics) training - the F4C and the F-105 realized their utmost advantage from maneuvering in a vertical plane, (dives and zooms) whereas the MIG's would gain the upper hand in the horizontal plane (high-G level turns).

All pilots involved gave great credit to the two-pilot concept of the F4C, and to the AI, both of which added to their ability to acquire and to keep the enemy in sight during an aerial combat situation.

This encounter, topping four months of frequent MIG engagements by USAF and by Navy fighters, apparently sent the enemy jet fighter force back to its former defensive, hide-and-seek role. MIG's were content to patrol the defensive rings around Hanoi and Haiphong, and to dart for sanctuary upon confrontation. For the next six months visual sighting of MIG's was a rare occasion, but in the four month flurry of air-to-air activity following the initial pair of F-105's lost, USAF and Navy pilots

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accounted for five MIG's without losing another U.S. aircraft.

### III. THE SAMS APPEAR

Another threat had shown up, however. Photo recce in April, 1965, revealed what appeared to be the construction of two SA-2 (Soviet bloc surface-to-air missiles) sites. This was confirmed in early May. <sup>10/</sup> No missiles had been delivered to the sites, nor had launchers appeared by mid-May. At the end of June, however, it was noted that a defensive circle of SAM sites around Hanoi was almost complete, with four sites <sup>11/</sup> ready for occupancy and a fifth (discovered on 4 July) under construction. The PACAF Director of Intelligence assumed a sixth and final site could most likely be built somewhere north-northwest of the city to complete the ring. (See illustration.) As yet, no SAM equipment had been positively identified at any of the Hanoi sites and it was speculated the Soviets intended to delay deployment of full complements of the SA-2 equipment until all six sites were complete. PACAF noted that full operational capability could be achieved within a few days after the <sup>12/</sup> construction was completed.

In May, PACAF Intelligence had raised the possibility that the <sup>13/</sup> construction of these sites might have been merely Soviet "showmanship".

"...The latest PI information reveals that the site is now in a condition of disrepair. There is evidence that concrete construction is in a state of erosion and the main roads in the site area are washed out. It is possible that the Soviets never intended to actually equip this site with an SA-2 launcher. This may only have been a pretense on the part of the Soviets to give an impression of supplying substantial military aid in the defense of Hanoi. The Soviets

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may also be afraid that if this site is completed it will cause U.S. air strikes against Hanoi. The Soviets may not want to have to cope with such a U.S. reaction."

This hopeful view underwent revision within the next few months as the magnitude of the construction effort became more apparent. As of <sup>14/</sup> 22 July PACAF DI said:

"...Covered and camouflaged objects are reported at some sites, and they could become operational momentarily. These SA-2 sites should be neutralized if strike force tactics require medium/high altitude operations within 27 NM radii. Construction of additional SAM launch sites is anticipated."

By mid-July ELINT aircraft (electronic intelligence) had confirmed the existence of "Spoon Rest" radar, a search radar associated with the SA-2, in the Hanoi area. <sup>15/</sup> An RB-66C ELINT aircraft operating over <sup>16/</sup> North Vietnam on 23 July intercepted "Fan Song" radar emanations. This is the "track-while-scan" radar used in the SA-2 guidance system. The RB-66 picked up two signals "possibly emanating from Fan Song A or B radar". Only one cut was obtained and it passed through a point about 23 nautical miles west of Hanoi where there were no known SAM installations.

Although there was still no positive confirmation that SA-2's were operational, all pilots preparing for missions into North Vietnam the next day, 24 July, were thoroughly briefed on the suspected SAM envelope around Hanoi, including the interception of Fan Song emissions the <sup>17/</sup> previous day.

Leopard flight, a flight of four F4C's from Ubon, Thailand, was flying MIGCAP (MIG Combat Air Patrol) over North Vietnam on the 24th of

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July. At approximately 2107° N/10509° E, in an area outside the suspected SAM envelope, the flight was in loose fingertip formation, at 23,000 feet between decks of clouds. They were enroute to their fraggd MIGCAP area when Lt Col William A. Alden, aircraft commander of Leopard 04 observed two missiles approach the formation from the right. <sup>18/</sup> The first missile exploded under Leopard 02 (flown by Captain Richard P. Keirn and Captain Roscoe H. Fobair) either by contact or proximity fuzing, <sup>19/</sup> and 02 immediately began burning from the trailing edge of the wing. As the formation broke and began violent evasive action, Leopard 02 rolled inverted and spiraled into the clouds. The other members of the flight were uncertain as to whether Number Two's crew ejected. The second missile was seen to pass behind the formation, climb and explode. <sup>20/</sup>

The flight formation had been close enough that all the aircraft <sup>21/</sup> suffered major damage. Two "instant lessons" were learned, along with one hard fact; close formation over North Vietnam was finished, and immediate violent evasive action was a useful defensive tactic. The hard fact was that the surface-to-air missile threat was an operational reality.

A study prepared by 7th Air Force Directorate of Operational Intelligence covering the first year of SAM/integrated air defense of North Vietnam said: <sup>22/</sup>

"...During the period 15 August (1965) to 15 December, the Air Defense of the heartland was completed. Sixteen SAM BN's had been deployed in full mutual support by mid-November; Kep Airfield was occupied by 18 September with a Combat Squadron (PLUS) of Fagot/Fresco /MIG 15/17/; Kep EW/GCI Command Center was established for the (Probable)

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Area Control and Integration of SAM/AAA/Fighter Forces; the North, Northeast and East SAM deployments were finalized with their full complement of AW/AAA. Concurrently, prime radar (sites) were deployed into these SAM areas; communications complexes and line of site /sic/ relay stations were deployed; and the entire system went through the full-phased force integration cycle. The "Heartland" Defense Embryo had been developed and methodically deployed."

The SAM, itself, did not pose an insurmountable problem; integrated, however, with a mix of good fighter aircraft, a strong AW/AAA base, a thoroughly sophisticated EW/GCI (Early Warning/Ground Controlled Intercept) capability and good communications, it presented a formidable array against our penetrating fighters.

The SA-2 Guideline is a Mach 3.5 radar guided missile, actually designed for medium to high altitude intercept of a subsonic non-maneuvering aircraft. Its capabilities, in its 24 July 1965 configuration, were such that it could guarantee an effective kill probability (if not degraded by counter tactics) from 1500 feet to altitudes well above the service ceiling of our tactical aircraft and at ranges out to 19 or 20 miles.<sup>23/</sup> It was incorporated into a fully automatic radar acquisition and tracking system, with semi-automatic or manual capability to counteract jamming.

(Spoon Rest or Flat Face radar for acquisition; Fan Song B radar for tracking.)<sup>24/</sup>

"...Of prime concern when developing or selecting appropriate counter-SAM tactics is a realistic evaluation of the threat. General war tactics have been developed around low altitude penetration of SAM-defended areas. This is a valid general war tactic, but does not automatically apply to a limited war. The difference in the two situations centers around the factor of geography. Intense AAA and small arms can be concentrated in

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a small area with relative ease. This represents a major threat to low flying aircraft in the defended area. This is the case in SEA today. A similar concentration of weapons throughout the Sino-Soviet homeland is another matter, although concentration could be expected in the target area. Optimum enroute survival tactics would continue to reflect the low altitude (below 1500 feet) profile requirement in a situation involving a thousand-mile penetration over open country. This would be the best way of avoiding the EW net and reducing enroute SAM exposure. However, when a 200 to 300 mile trip over an area of intense small arms and automatic weapon concentration is required, the low altitudes (below 4500 feet) become unlivable. Some recent press releases have indicated that the SAM's in North Vietnam have been ineffective as air defense weapons when compared to conventional AAA. This is true in terms of aircraft destroyed, but does not reflect a true picture at all. The SAM exposure in many areas of North Vietnam initially dictated low altitude penetrations, resulting in losses to conventional weapons which would not have occurred had we been able to overfly at higher altitudes. Obviously a compromise had to be developed between the high and low altitude penetrations which would keep strike and reconnaissance aircraft above the conventional weapon envelopes and at the same time provide for escape in the event of a SAM engagement." 25/

#### IV. RETALIATION STRIKE OF 27 JULY 1965

This was a bitter lesson learned the hard way. Following the initial SAM shootdown of Leopard 02, a retaliatory strike was set up with the aim of destroying SA-2 sites Six and Seven, determined by photography as being 28 and 30 miles west northwest of Hanoi, and presumed to be the launch location of the missiles of 24 July. On 27 July, a strike force of 54 F-105's loaded with napalm and CBU, along with MIGCAP and ELINT support aircraft, set out for five targets. Eleven Thunderchiefs were to hit SAM site Six, 12 went against SAM site Seven, eight were to strike the

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missile-associated Phu Nhieu barracks, 15 against the Cam Doi barracks area and eight F-105's were scheduled to fly a special armed reconnaissance in the area. <sup>26/</sup> The aircraft were into the target area shortly after 1400L on the afternoon of 27 July. Lemon, Poplar and Cedar flights hit the Cam Doi barracks, with Lemon first in to the target. Flying four abreast at altitudes between 50 and 100 feet, Lemon flight flew through heavy, accurate AW/AAA to deliver its CBU's; Lemon 02 and 04 both were hit, but made it through. Cedar flight, three F-105's abreast, came through 11 minutes later; Cedar 02 took hits and crashed in the target area with no parachute being observed by the other members of the flight. Poplar flight got through the barrage of fire without being hit.

Pepper flight struck SAM Site Six at 1410H with CBU-2, dropping from an altitude of 200 feet and a speed of 500 knots. Pepper 02 was hit in the nose section during the run, and later, on the trip home he asked Pepper 04 to check over his aircraft. As Pepper 04 came alongside, 02's plane suddenly pitched up and into 04. The two aircraft formed one mass of fire and falling wreckage. One parachute was observed coming out of the wreckage but it streamered and fell to the ground without fully deploying. This took place only 14 nautical miles south-southeast of Udorn, Thailand. It was suspected that the mid-air collision was caused by enemy ground fire damaging the control system of Pepper 02. <sup>27/</sup>

Austin and Hudson flights, with two minutes separation, dropped napalm at Site Seven, Austin attacking in line abreast and Hudson from fingertip formation. Two F-105's went down. One crashed in flames in

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the target area; the other managed a successful ejection. This pilot landed in the Black River where his life raft was seen by other pilots although they observed no survivor. <sup>28/</sup>

Captain Frank Tullo was Dogwood 02 in a flight of four F-105's accomplishing the special armed recce over the SAM target complex. <sup>29/</sup>

During the period of attack, Dogwood Flight heard both SAM and MIG alerts called out. Captain Tullo had crossed the first target, a barracks area, at 1000 feet when he saw flak off to his right. He and Lead attempted to break left away from it. In the intense ground fire, the maneuver was unsuccessful and he was hit. Tullo immediately climbed and turned southwest for high ground, looking for a favorable spot to eject. He was able to stay with the aircraft for only one or two minutes after being hit and then, in short order, experienced a fire and explosion, followed by loss of control and flameout. As his plane started a slow pitch forward he punched out at 400 knots at about 5000 feet. Tullo descended into dense scrub brush in some low rolling hills and was picked up by CH-3C helicopter approximately two hours later. <sup>30/</sup>

Of the 54 aircraft that took part in the retaliatory strikes, six were lost. One pilot was rescued; the bodies of two others who crashed near Udorn, Thailand, were recovered. Two pilots apparently crashed with their aircraft in the target areas and another, who successfully ejected, appeared to have drowned after landing in a river. <sup>31/</sup>

RF-101 photography taken the next day showed no significant

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damage to either site. Site Six appeared to be set up as an imitation SAM site, possibly a decoy and flak trap. Site Seven appeared unoccupied, <sup>32/</sup> and no damage to the revetments or associated structures was noted.

V. ELECTRONIC COUNTER-MEASURES

No one seriously questioned the threat that the SAM/AAA combination posed. Obviously, tactics had to be modified or evolved to present the greatest chance of survival to our strike pilots. Early in August, a special ground alert force, code named IRON HAND, was set up to respond to ELINT or other intelligence sources which located any SAM site. The IRON HAND flight of F-105's was to neutralize the site. <sup>33/</sup> Unfortunately, in its ground alert posture the IRON HAND concept did not prove out, and within a week these aircraft were fragged for armed reconnaissance over the north.

The 41st Tactical Reconnaissance Squadron was put in place in SEA in April, 1965, for the purpose of providing EW/ECM (Early Warning/<sup>34/</sup> Electronic Counter-Measures) over North Vietnam. The RB-66B/C carried electronic equipment capable of acquiring and also jamming virtually any given frequency in the NVN radar spectrum. It was this aircraft which first acquired the Fan Song emanation on 24 July. Its contribution to the overall effectiveness of our air warfare over North Vietnam was noteworthy, for it was this EW/ECM function that made survival of U.S. strike aircraft in this radar and gun-filled environment at all possible. Here again, however, the task was a difficult one. Some 20 different types of radar threats were noted in North Vietnam, ranging through early

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warning, height finding, SAM acquisition, SAM tracking and guidance, gun-laying and airborne intercept. Added to these were other electronic emissions such as IFF, radio communications and friendly radar and radio. <sup>35/</sup>

Among the most difficult of the NVN radar capabilities to nullify were their EW/GCI (Ground Controlled Intercept) radars, which had a large frequency diversity, good overlap of coverage, and an effective crosstell communications network. The large frequency diversity required U.S. ECM aircraft to carry a wide variety of jammers in order to provide full spectrum capability against all the frequency bands. Further, their principal EW/GCI radar were equipped with anti-jam features and were not too vulnerable to a single ECM aircraft. This forced the 41st TRS to employ several RB-66's against a single target, or group of targets, using a combination of electronic jamming, chaff and crossing tracks. While these tactics did considerably degrade the EW/GCI in any given vicinity, they could not completely degrade the entire NVN system. The North Vietnamese, with experienced air defense filter centers, could maintain their overall picture of the air situation (and a considerable portion of that target area under direct jamming by ECM aircraft) by using information from unjammed radars, communications crosstell, ground observers, dead reckoning and jamming strobe cross-plots. <sup>36/</sup> The same difficulties applied to the jamming of the Spoon Rest and Flat Face SAM acquisition radars. <sup>37/</sup>

Against the S-Band Fan Song tracking radar ECM was somewhat simplified, although many aspects were still critical. The Fan Song

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antenna continues sweeping while tracking the target, which is peculiar to this particular radar. These target trackers essentially use two separate radars employing flat beams, one swept horizontally and the other vertically. The two beams never stop on or rotate around the intended target but continue to scan in the same manner as before the target was acquired; thus the term track-while-scan (TWS). Its primary advantage is that it can search for another target while still tracking the first; there is no way of knowing which aircraft is being tracked.<sup>38/</sup> It was operationally determined that range information (from its horizontal scan) could be denied the SAM battery by the use of jamming, chaff and low-altitude penetration (below 4000 feet). However, the SA-2 had an automatic track-on-jam capability which provided a good kill probability against a single jamming aircraft; this was reduced considerably by simultaneous jamming by two ECM aircraft. Since the aspect ratio (angle between the penetration approach route of the strike force and the position of the RB-66's) was a critical factor in determining the effectiveness of the ECM versus the range of the Fan Song, the 41st made every effort to place their aircraft along the ingress/egress route of the fighters.<sup>39/</sup>

Results of ECM support against surface-to-air missiles appeared to be quite effective. Many reported missile firings were either completely out of control or grossly inaccurate, and while it was impossible to attribute this lack of missile effectiveness entirely to ECM support, it was believed that the electronic counter-measures employed by the 41st

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TRS RB-66's contributed to a significant degree. <sup>40/</sup>

As effective as the ECM aircraft were, there were drawbacks which pointed up the need for some further tactic to degrade the SAM/AAA threat. The RB-66 was a low-survivability aircraft if it went too deeply into North Vietnam, either against MIG's or optically sighted AAA, or even against SAM's and radar gun laying AAA if the enemy could achieve a radar breakthrough of the ECM defenses. For this reason the RB-66's had to maintain a stand-off posture, for the most part. In the meantime, the NVN AAAOB had increased multifold and the number of SAM sites and installations grew monthly, expanding outward from the Hanoi point defense. The original deployment of the SA-2 system around Hanoi and out to the northwest rail line was preceded by heavy, new-type radar activity and the introduction of both massed and area AW/AAA. <sup>41/</sup> The automatic weapons and anti-aircraft artillery were massed in the immediate area of the SA-2 battalion and positioned as far as 30 miles along major LOC's.

By August, the secondary SA-2 deployment was noted into the Phy Ly, Nam Dinh, Ninh Binh area, following the same time and deployment patterns. The third and fourth deployment areas, in September, went into the Thai Nguyen and northeast railroad areas. In October, the Haiphong cartwheel was set up and, by November, the basic deployment was completed with additional, mutually supporting battalions affording total Heart-land coverage. This filler deployment was marked by the growth of the EW/GCI and communications systems, and the AW/AAA was subordinated to the SA-2 command. <sup>42/</sup>

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VI. WILD WEASEL/IRON HAND

This presented an untenable survival envelope to the slow and ungainly RB-66, and increasingly denied the effective use of the skies over North Vietnam to our strike forces. USAF sought some means to restore the freedom of air operations in the medium and high altitude regions, having had it amply demonstrated that continued survival in the low altitude AW/AAA envelope was not to be had. Yet the SAM forced our aircraft down into it. The answer appeared to lie in suppressing the SA-2. IRON HAND alone had not proved practicable. Photo reconnaissance, which could pinpoint the target, gave the SAM site six to eight hours to relocate, ample for the SA-2. ELINT and other intelligence gathering facilities could locate SAM installations in general areas, but could not pinpoint them with sufficient accuracy to allow an IRON HAND flight to acquire them. The North Vietnamese were expert at camouflaging their sites. A search and destroy concept called WILD WEASEL, in conjunction with IRON HAND aircraft, evolved as one of the best and most readily attainable methods of locating and knocking out SAM installations. <sup>43/</sup> Essentially it involved an F-100F, configured for electronic homing, to lead a flight of F-105's to the SAM installation, and mark it for the F-105's to destroy. Three pieces of equipment were installed in the WILD WEASEL aircraft which provided a capability of detecting S, C, and X band radar and, after detection, could home on the source with a high degree of accuracy. This electronic equipment consisted of the Radar Homing and Warning System (RHAW), the Panoramic Scan Receiver (IR-133)

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and the Missile Guidance Warning Receiver (WR-300). All the items were located in the rear cockpit of the F-100F and were operated by an Electronics Warfare Officer (EWO). The scope on the APR-25V RHAW system was duplicated and positioned in the front seat for the pilot's monitor. <sup>44/</sup>

When a threat radar came on the air, the signal was received and put to a series of tests by the APR-25 which, through logic, assessed the frequency, PRF (pulse repetition frequency), the pulse width and power, and displayed the signal on both front and rear cockpit scope. The scope display was in the form of a beam or strobe which varied in characteristic according to the signal received, a steady line for the gun-laying Fire Can a straight line flashing 15 times per second for the SAM's Fan Song S-band. This equipment could home on an emission with an accuracy of only plus or minus 10 degrees. With the IR-133, however, the EWO could "fine-tune" on a source and home on it within one or two degrees and, at the same time, analyze and evaluate the threat potential. The third receiver, the WR-300, was omni-directional and tuned to the signals radiated by missile guidance equipment. Its function was to tell when the guidance signal came on the air and when missile launch was imminent, so that the flight could begin evasive action or hit the deck. One circuit activated an amber light whenever there was any activity within the frequency spectrum (700-850 mcs); a second circuit gave a red light readout whenever it detected a launch imminent condition. <sup>45/</sup>

Basically, the WILD WEASEL aircraft had the capability of leading the IRON HAND flight to a radar source with sufficient accuracy to

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allow visual acquisition and subsequent ordnance delivery. Signals from a threat radar could be detected at greater distances than the effective missile range; in addition, at no time could the threat radar track a WILD WEASEL aircraft without introducing a warning signal into the aircraft's equipment. Cross utilization of the equipment, capitalizing on the best features of each, could give accuracies of station passage in the range of 100 feet. <sup>46/</sup>

The first WW F-100F's arrived in-theater in November, 1965, and were assigned to Korat AB in Thailand to work with the F-105's of the 388th Tactical Fighter Wing. <sup>47/</sup> During the period 26 November 1965 to 5 February 1966, five definite and possibly six SA-2 installations were overflown by WILD WEASEL/IRON HAND teams. <sup>48/</sup> Tactics gradually evolved into two basic types of penetration, medium altitude and low altitude, each with its four phases of search, homing, attack and withdrawal. The basic lineup for these SAM search and destroy missions had the F-100F leading three F-105's into the target. In the medium altitude attack, the flight would break down into two loose elements, with the second flying 2000 to 4000 feet behind the first. Altitude for the search was from 4,500 to 15,000 feet, above the AW/AAA/small arms area, but at a low enough altitude to dive for the deck should SAM launch appear imminent. When a Fan Song propagation was picked up, the WILD WEASEL aircraft could either home in directly, at altitudes between 4,500 and 8,000 feet, or drop down low for terrain masking. If the aircraft remained at altitude, they constantly employed cross-overs, varying headings and altitudes until station passage. Attempts were not made to fly

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directly over the emitting radar, but to try for an offset of 100 to 500 feet, to make the target easier to acquire visually. Once the installation was found, the F-100F would try to mark it with rockets, so that the F-105's could unload their heavy ordnance. Some of the terrain in North Vietnam was suitable for the terrain masking technique of homing, especially in the western area inland where numerous ridges and valleys provided a physical shield against radar. In this tactic, the flight flew at normal search altitudes until a signal was located and a bearing determined. Then the flight would descend below the line-of-sight altitude, flying up valleys and over ridges, popping up to obtain another bearing, and then descending again. The greatest advantage of this tactic was the element of surprise. In some cases it was possible to surprise not only the missile defenders but the fire control and gun positions as well. <sup>49/</sup> Further modifications (addition of more modern aircraft and innovations in ordnance) turned the WILD WEASEL/IRON HAND concept into a hard hitting and more effective SAM and flak destroyer (covered later in this study).

#### VII. MIG/SAM INTEGRATION

All ELINT collectors (three EC-121D's introduced in April 1965 for MIG-warning, called BIG EYE, four EC-130B's in September 1965, called SILVER DAWN, plus Navy sources and EB-66C's) pointed to the rapid integration of the North Vietnamese air defense system. The BIG EYE Task Force deployed from McClellan AFB, California in April 1965, and established MIG warning operations in early May. <sup>50/</sup> A 30 mile racetrack pattern was established over the Gulf of Tonkin about 50 miles out from

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North Vietnam, at altitudes varying from 50 to 300 feet (this radar system's optimum effectiveness is achieved when its beam is reflected from and supported by the water's surface at a very low altitude). <sup>51/</sup>

BIG EYE aircraft had no ECM equipment, but their AN/APS 95 search radar painted MIG tracks deep into North Vietnam and supplied MIG warning to our strike and CAP aircraft. From their Tonkin Gulf stations the EC-121D's extended early warning coverage and the capability of aircraft control over North Vietnam, the Gulf of Tonkin, Hainan and parts of China. Two of the BIG EYE aircraft were normally put on station whenever out-of-country strikes were in progress; one exercised primary control while the other worked secondary missions and stood ready to assume the primary. Prior to going on station an EC-121 made a radar check on a fighter. If he was unable to "skin paint" the fighter (no IFF) at least seven out of ten radar sweeps at a range of 140 nautical miles, that EC-121 did not take station. This consistent radar coverage made it possible for BIG EYE to issue the MIG alert, along with position, range and bearing, which set up the first USAF MIG kills in Southeast Asia on 10 July 1965. <sup>52/</sup>

As the months went on BIG EYE and the other ELINT gatherers determined increasing integration between these MIG's and enemy GCI, observed the buildup of early warning and height finder radars in North Vietnam, and watched the interplay between SAM electronic configuration and MIG overflights, until it became apparent that a MIG/SAM test of our air capabilities would soon come.

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In October, 2nd Air Division DIO sent the following memo:

FROM: DIO-D

31 October 1965

TO: General Simler

SUBJECT: MIG Threat

"During the past month (a) few factors have become evident in MIG threat activity. An integrated fighter-SAM system has become a necessity. The operational capability of a MIG vector on U.S. aircraft (probably to sighting distance) and a subsequent run through a SAM area must be tested. When this is, in fact, happening it will be difficult to determine (except in the Hanoi ring) due to the situation of constant mobile /SAMS/ systems redeployment. The ultimate objective of this tactic would be to force U.S. aircraft into a pursuit position. Were this to occur, the entire process of target assignment (fighter responsibility), GCI, target reassignment (SAM responsibility), positive ID, (Fighter-SAM integration) and discriminate missile launch upon SAM area penetration would be tested. All pilots must be made aware of this tactic in order that force protection will not suffer from a dual system ploy." 53/

Twenty-five days later the MIG's came out in a test quite similar to that envisioned. Approximately three MIG's engaged four Navy A4E's as they started bomb runs on the Me Xa Highway Bridge. At least one of the MIG's made a firing run against the Navy aircraft, and one air-to-air rocket and one long burst of machine gun fire were observed. None of the A4's were hit. Within minutes of this engagement (1448 local, 25 Nov 1965) at least two MIG's made firing passes at the last two planes of another A4E flight. One of the A4's, call sign Warpaint 550, was hit by one round of suspected 23mm cannon fire. The other was engaged by two MIG's in low altitude air-to-air combat for about five minutes before disengaging without damage. It could not be ascertained whether the same

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MIG's (Frescos) made all the attacks or if there were more than three. Pilots reported seeing two stripes around the aft fuselage of one of the MIG's, and a large star on the tail. One pilot described a solid red star and another reported a good view of a dark colored star with a yellow border. As described, the tail markings were Soviet (North Vietnam markings had a yellow star with red trim; Chinese Communist markings were a red star with yellow trim and a horizontal banner, and yellow markings within the star). 54/

In a memo for record from 2nd Air Division DIO it was noted that:

"...No SAM's were fired despite the fact that there are at least three Bat's in the immediate area.

"This is the first overt attempt by NVN (?) MIG's at sustained air-to-air intercept - combat prior to U.S. A/C TOT.

"No MIG red warnings were issued.

"SILVER DAWN aborted one hour prior to TOT.

"CONCLUDE: This was a preplanned intercept and target assignment to the MIG A/C only. The SAM forces did not receive a target assignment in lieu of this first major test. These engagements will continue at a stepped up pace. The MIG Fighter Force has come of age." 55/

The last statement was not yet quite true. The MIG force was not to be "of age" for some months. In the intense ground fire base of North Vietnam, the integration of a fighter force numbering in excess of 100 aircraft could not be easy. Their rules of engagement could be laid out, but practice was difficult under the constant combat environment. Ground fire elements had to be tightly controlled, with firm fire discipline,

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prior to actual engagement by their fighters. It would do no good for the North Vietnamese gunners to fill the sky with flak, if the flak were endangering their own fighters. All elements had to be under firm sector control to assure that there would be no interaction between their own forces. In addition, the training of their pilots, in what was in essence a fledgling air force, had to take place under actual combat conditions, which could account for one of the puzzles of most air-to-air combat up to that time. Despite the fact that MIG's had been in the six o'clock position on American fighters at least 15 times, there had been only four firing passes. This was probably a combat situation type training for both pilots and GCI crews, wherein the interceptor was GCI positioned in the target rear hemisphere and the moment he made visual contact the GCI was considered successful and the MIG would break off. In the early stages of a fighter force creation it would be unwise to begin hard engagements until such time that proficiency in the entire air defense system had reached a point where mass retaliation became impossible. <sup>56/</sup>

#### VIII. THE DEFENSE SITUATION IN EARLY 1966

Following mid-December 1965, the North Vietnamese heartland defenses concentrated upon sophistication and upgrading of equipment and tactics. SAM/AAA elements and prime radar sites spread into the Thanh Hoa and Ha Tinh areas; NVN fighter inventory increased to an estimated 125 fighters; 53 aircraft crates were photographed at Phuc Yen airfield of which 23 were FISHBED (MIG-21) types; this in addition to the 14 confirmed and one probable MIG-21's. The early warning radar system was further type-

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upgraded. Radar, AAA's and SAM's began to display a high degree of discipline. The three systems were fully integrated under an excellent command and control net which, of necessity, extended to the fighter force also. <sup>57/</sup> This was a methodical, high caliber, tight control, multi-directional defense development, and it is significant to note that what took seven years to set up in the Soviet satellite bloc, took but seven months (from April 1965 when the first SAM sites were photographed) in North Vietnam. <sup>58/</sup>

With the advent of the bombing pause against North Vietnam (24 Dec 65 to 31 Jan 66) the Hanoi government found an unopposed opportunity for increasing the air defense system. They did not waste it. A CINCPACAF intelligence summary of 14 January gave the NVN SAMOB (SAM Order of Battle) as 66 sites, nine installations (photography) and 37 possible installations (ELINT). <sup>59/</sup> By 15 February the list was 84 sites, 11 photographed installations and 39 ELINT-gathered possibles. <sup>60/</sup> The AAAOB also grew, and spread into areas where it had not been seen before. The first week's resumption of air activities into North Vietnam gave intelligence several indicators of the overall air defense posture. There appeared <sup>e</sup> definitely to be an increase in the rate of AW/AAA engagements. Flak remained intense along Route 1A from Dong Hoi to Thanh Hoa, anti-aircraft weapons were deployed in considerable numbers along Route 7 from 105 degrees to the Laotian border, and on the lines of communication from Thanh Hoa through the Bai Thoung airfield area. In addition, ground-fire was being received on the western side of North Vietnam in several locations

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where flak was not normally received prior to the stand-down. <sup>61/</sup> There also was little doubt that the MIG's were also ready for active engagement. Two instances of importance took place in the first week following the resumption of strikes in the north. <sup>62/</sup> The first was a night engagement of a Marine F4B flight by an unknown number of MIG-17's on 3 February, 1966. At the time of the attack the Marines were in escort orbit near the Laotian border. The MIG's showed every intention of engaging in a prolonged flight, and made four firing passes, breaking off and returning for reengagement each time. One maneuver used by the MIG's was to dive for the deck (and ground clutter) in an attempt to reduce the F4B AI radar capability. Also, the attack took place during the closing moments of the recce patrol and thus took advantage of the friendly fuel limitations. <sup>63/</sup> The second instance involved attempted intercepts of a TROJAN HORSE U-2 aircraft by MIG-21's over Dien Bien Phu. On 6 February, a TROJAN HORSE pilot at 68,000 feet sighted a Mach 2.0 bogie at 60,000 feet heading south on an intercept course. The U-2 pilot photographed a MIG-21, with one probable missile on each wing rail, as the communist jet passed directly beneath him. About 20 minutes later, the pilot of the U-2 saw another bogie heading for him at 65,000 feet over Sam Neua, Laos. As the TROJAN HORSE aircraft broke to the right, the bogie broke left and headed into North Vietnam. The area of the passes was well outside the zone in which other MIG's had been sighted, indicating not only a new aggressiveness, but possibly an increased interest in air activity to the west and southwest. <sup>64/</sup>

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IX. REFINEMENT OF SAM TECHNIQUES

On 25 February 1966, an RB-66C on a harassment and ELINT collection mission in the vicinity of Vinh was downed by an SA-2 missile. <sup>65/</sup> A reconstruction and analysis of the enemy's electronic data gathered prior to and during the shootdown demonstrated conclusively the refinement to which they had brought their radar/SAM teams. The RB-66, out of Takhli, Thailand, coasted inland about three nautical miles north of Vinh at about 1541H local time; it was hit approximately four minutes later, at 1545H, 13 miles northwest. Prior to its initial "on watch" time at 1524H, when three Spoon Rest (SA-2 acquisition radar) signals were picked up, the aircraft was probably on the enemy's plotting boards. The RB-66 began a chaff drop at 1525H, and began jamming the Spoon Rest emissions at 1530H; by this time the ground sites knew the mission of our aircraft. The jamming was apparently effective, as one Spoon Rest operator altered his scan in an attempt to reduce interference. At 1535H, when Fire Can (AAA gun laying radar) jamming began, a Rock Cake height finder also came on the air. During this entire time period, Fire Cans were coming up and going down without evidence of lock on. To this point it was evident that the enemy had established good radar tracking and plotting for FAN <sup>66/</sup> SONG (SA-2 TWS radar) targeting.

At 1538H, the APS-54 warning receiver recorded a short burst of a very weak Fan Song signal in low PRF and jamming of this propagation immediately began. At 1543H the signal again came up, this time strong and in high PRF. The EW supervisor, noting the emission indicated a possible

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imminent launch, notified the pilot to turn left. At 1545H another EW operator detected an L-Band (missile guidance signal) emission on 760MC. It took about 10 to 15 seconds to identify this signal and to begin jamming it. About five seconds later the burst occurred. <sup>67/</sup>

The pilot was the only man to see the explosion of the SAM. The navigator saw a flash, and all survivors felt the burst. The pilot said that he was in a steep left turn when the missile exploded, and likened it to a large white billowing cloud which appeared to be several times larger than his aircraft. After the burst the pilot allowed the nose to fall and dove to 20,000 feet, where he righted the aircraft. Control difficulties progressed, however, until he finally lost all control of the aircraft, and the crew ejected over the water, with the exception of the EW Supervisor who was lost. <sup>68/</sup>

It was apparent that previous acquisition and height finder radars provided sufficient information to the SA-2 site to enable it to reduce its exposure time, yet gave it enough data that it could plot and track the RB-66C. It is also very probable that the Fan Song was initially operating in dummy load, as indicated by the weak signal first intercepted. Although jamming was begun at this time, vital target information was already available and had already probably been programmed by the Fan Song. It was assumed that this successful tactic would continue to be used; that aircraft positions would be relayed by acquisition, height finder and fire control radars into the SA-2 computers. The SAM site itself would be on the air a minimal time to avoid detection and suppress

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the alerting of strike aircraft to a missile threat. With accurate target information available from other resources, Fan Song was able to by-pass the low PRF sequence, going to high PRF for a minimum time to obtain final refined data, and then launched with sufficient accuracy to destroy the aircraft. <sup>69/</sup>

Despite this refinement in technique, the SA-2 did not get notably more efficient in actual kills of aircraft when proper evasive tactics were used. Those SAM hits which did destroy aircraft almost invariably took place when the plane was in the SAM's effective altitude envelope (above 1500 feet) and when the aircraft failed to take high-G evasive action. A rare period of SA-2 apparent effectiveness took place between 19 July and 1 August, 1966, when the enemy scored four (possibly five) kills. An analysis of these hits, however, did not appear to support increased SA-2 effectiveness. <sup>70/</sup>

1. "...19 July - SUPERHEAT 3, an F8E suffered a direct hit from an SA-2. The other aircraft in the area, upon SAM warning, took evasive action. SUPERHEAT 3, who had some radio difficulty, continued in straight flight and was hit at 6,000 feet.

2. "20 July - DEVIL 1, an EB-66C, on an ELINT mission at 29,000 feet, suffered fragment damage and was lost to an SA-2. The EB-66C had taken evasive action sufficient to cause the missile warhead to detonate a reported 2,000 feet from the aircraft.

3. "On 23 July - DRILL 1, an F-105, was subjected to a close SAM burst while being engaged by AAA. He was within the effective SAM altitude at 3,000 to 4,000 feet, but positive determination of the weapon causing the loss is impossible.

4. "On 1 August - FLIP 1, an F-104, was lost at

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5,000 feet to an explosion that can only be correlated by size and color to a SAM. The flight did not observe the missile and violent evasive action was not taken.

5. "On 1 August - DAGGER 2, an F-104, was lost at 4,500 feet. The only warning was verbal from an IRON HAND flight and from DAGGER lead who saw the missile. The other three aircraft pushed over violently but number 2 rolled inverted and had just started pull-down when the missile struck behind the canopy.

"It becomes apparent that in all cases except the third one, DRILL, the aircraft were at favorable altitude for the SA-2 system. In addition, they had taken no evasive action or had only initiated such action prior to being hit. The third case, DRILL ~~X~~,<sup>1</sup> may have *QW* been lost to ground fire. In the case of the EB-66, gross bad luck was the salient factor, since the probability of a lethal fragment striking an aircraft at a 2,000 foot range is extremely remote. It can, therefore, be concluded that the enemy has not significantly increased his SA-2 effectiveness. His rate of success for all of 1965 through 25 April 1966 was 11 missiles fired for each kill. From 20 July to 2 August 1966, he averaged 13 missiles for each kill."

When sufficient warning was received and proper evasive taken, the results were altered, often spectacularly, as in the report of an F-105F pilot who out-dueled a SAM "face-to-face": 71/

"...obtained an SA-2 launch indication on their warning receiver. The flight broke down and saw two GUIDELINE missiles launched at them. They also visually acquired the site because of the cloud of dust caused by the launch. One SA-2 missile guided on the flight and impacted on a hillside, missing the aircraft by 2,000 feet. A second GUIDELINE closed on the F-105F from its eleven o'clock position. The pilot dove to 200 feet AGL and saw the missile descend. He waited until the missile had closed to the point where it would not be able to maneuver and complete an intercept if he changed course abruptly, and then pulled up. He saw the missile attempting to follow but passing beneath the aircraft and exploding approximately 500 feet below him."

As SAM techniques were refined, USAF defensive tactics - ECM/ELINT early warning, evasive actions were refined with them. These very defensive tactics with the addition of more sophisticated weaponeering, were

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useful in developing offensive tactics against both SA-2's and gun-laying radar in North Vietnam.

X. WILD WEASEL USES THE SHRIKE

If the effectiveness of the SA-2 in achieving direct "kills" against U.S. aircraft stayed low, its effectiveness in driving these aircraft into the lethal AW/AAA envelope stayed only too high. It remained the responsibility of the WILD WEASEL/IRON HAND flights to seek out and destroy the SAM installations. The primary deterrent to successful SAM suppression was the difficulty of physically locating the installations under superb camouflage. In an effort to pinpoint these targets, the AGM-45 Shrike (air-to-ground) missile was employed. The Shrike was launched from a USAF aircraft for the first time in Southeast Asia on 18 April 1966. An F-100F WILD WEASEL aircraft, leading a flight of three F-105's on an SA-2 search and destroy mission in Route Package I, detected a Fire Can emitter six miles northwest of Dong Hoi and launched the radar-homing missile. <sup>72/</sup> The F-105 pilots tracked the missile, intending to deliver additional ordnance in the area of the AGM detonation. The Shrike, however, disappeared in a haze layer and was not visually reacquired, but shortly thereafter the Fire Can went off the air and did not come back up for the remainder of the mission. It was estimated that the launch was successful. <sup>73/</sup>

Most of the early USAF Shrike attacks took place in Route Package I because this was an ideal area in which to develop operational tactics; the radar emitters were more geographically isolated than in the heavily

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clustered Hanoi/Haiphong rings and this lowered the possibilities of radar ambiguity in detection and tracking by the missile. This first launch caused an almost immediate change in the Fire Can mode of operation in Route Package I. Where before, the gun-laying radar would come up as soon as aircraft entered their area and would remain on the air for ten to twelve minutes, the enemy greatly reduced this on-air time to a very few minutes - seldom more than two or three - and often intermittent and sporadic. <sup>74/</sup> In this sense, the introduction of the Shrike performed a worthwhile function whether the missiles were actually launched or not, in that they tended to degrade enemy radar by reducing active emission time.

Within a few weeks, more and more radar shutdowns were observed, both prior to and after Shrike launch. The conclusions drawn were that, when radars shutdown before the launch, IRON HAND tactics had been identified; if after launch, then the missile itself had been observed either visually or by radar. To counter this, WILD WEASEL/IRON HAND strikes were fraggged into areas where other strikes were to take place. If Fire Can or Fan Song were to be effective against the programmed strike aircraft, they had to give their position away to the WILD WEASEL RHAW-equipped aircraft. <sup>75/</sup> On 28 May, after the first five weeks of USAF Shrike operations, a comparative study was drawn up in an effort to determine its effectiveness: <sup>76/</sup>

Total Missions Flown	62
Missions with Shrike launches	21
No suitable radar targets	38

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Weather in target area	3
Shrikes launched	32
Excellent probability of hit	4
Fair probability of hit	10
Radar vans observed	0
Impacts observed	8

(Probable hits based upon signal shutdown at computed time of missile impact.)

From this data and pilot debriefings several things were apparent. Enemy camouflage (or natural jungle cover) made accurate BDA (damage assessment) virtually impossible, especially since the Shrike left no distinctive marker and its destruction was limited to tiny holes. It also was indicative of something that had been noted before, but which was now becoming commonplace - the enemy's emission control (emcon) was becoming highly disciplined. Even with the existing shortcomings of the early Shrike and regardless of the risk involved on IRON HAND missions, <sup>77/</sup> commanders unanimously endorsed the concept as the only way to make the skies livable over North Vietnam. Colonel Monroe S. Sams, commander of the 388th Tactical Fighter Wing, felt that the seriousness of the SA-2 threat could not be overemphasized - that it actually denied U.S. air superiority in SAM-defended areas - and that WILD WEASEL with Shrike

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provided the only answer. In his End of Tour Report, 6 August 1966, he said in part: <sup>78/</sup>

"...Although the percentage of aircraft losses are small /losses to SA-2/ compared to losses from ground fire, the SAM threat forces the strike aircraft to modify the desired flight plan and tactics to survive. Many of the aircraft losses to ground fire can be directly attributed to the SAM threat forcing them to lower altitudes than desirable. Numerous targets have not been acquired or hit because the strike force could not go into the target at the desired altitude and were forced to use 'Pop-up' tactics which allow only a few seconds to acquire the target and decreases bombing accuracy. Many times the strike force must jettison their ordnance and take hard evasive maneuvers to evade launched SAM's. The accumulation of lower altitudes, target acquisition, decreased bombing accuracy, and jettisoning of ordnance, makes the SAM threat a serious deterrent to our mission. 'WILD WEASEL' aircraft accompanying a strike force into a SAM defended area offer the best solution to the SA-2 problem.

"...The Shrike increases the flexibility of WILD WEASEL operations due to the fact that it can be launched against an installation without visual acquisition. A white phosphorus warhead on the AGM-45 would allow this weapon to become a marking device, it would assist in acquiring the highly concealed radar vans and associated equipment so that bombs and rockets would be used for the total destruction of the installation."

The request had already been forwarded for more hunter-killer aircraft, specifically WILD WEASEL III and IV (F-105F and F4C, WW configured), and on 27 April, 7th Air Force passed on word that six F-105F's would be assigned to Korat not later than 1 June 1966, and that four F4C WILD WEASEL aircraft would arrive at Korat in July. All F-100F's were to be returned to CONUS by July. The 355th TFW at Takhli was to receive five F-105F's by 7 May. <sup>79/</sup>

These aircraft went into action at once. After supporting the

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dramatic Thanh Am and Nguyen Khe POL strikes on 29 and 30 June 1966 in the very teeth of the Hanoi SAM ring without loss, the F-105F's went on to score heavily throughout the month of July. On 5 July, an IRON HAND flight of one F-105F and three F-105D's struck four SA-2 sites in rapid succession in a day featuring the wildest, largest missile-fight of the war to that date. A total of 16 SAM's were launched in Route Package V and VI. The flight attacking the four sites was Eagle flight from Korat.<sup>80/</sup> At 1520H Eagle flight struck a site at 2137N/10509E. Photography showed that one missile was rising from the launcher during the attack while support structures were burning less than a half mile away. Ten minutes later Eagle lead launched a Shrike at site VN-457 (2121N/10608E). Just prior to Shrike impact the installation fired a SA-2, which would indicate that the Shrike still had a radar emission to home on during its terminal phase. The flight had to break north because of yet another SAM launch, but as they broke they observed the Shrike explode over the site, producing a secondary explosion.<sup>81/</sup> The flight flew northwest where they picked up another site at 2145N/10520E with rockets and 20mm cannon fire. The flight reported the Fan Song destroyed. At 1541H, Eagle 2, who had become separated from the flight during the break off VN-057, hit an SA-2 installation by himself, at 2145N/10550E. He penetrated heavy AAA and AW defenses and fired rockets into the site, and observed a flash and fire as he departed the target area.

A 15 July summary and evaluation of 107 Shrikes launched by USAF fighters since the 18 April strike showed again the difficulty of assessing damage:<sup>82/</sup>

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<u>MONTH</u>	<u>LAUNCHED</u>	vs	<u>FIRE CAN</u>	<u>FAN SONG</u>	<u>EW/GCI</u>	<u>HITS</u>
April	4		4	--	--	2 Probable
May	33		27	3	3	1 Confirmed/ 12 Probable
June	34		19	14	1	15 Probable
July (1-15)	36		--	36	--	9 Probable

While the method of determining Shrike results was far from conclusive, since few impacts were observed and the "shotgun" pattern of the pellets was not readily detectable by photography, there was evidence that the Shrike attacks were effective. Besides the intermittent and sporadic mode of radar operation, it was specifically noted that whenever WILD/WEASEL/IRON HAND flights altered their heading to launch a Shrike, the radar emissions ceased abruptly. Evidence grew that the attacks had a definite harassment effect on the radar operators, causing apprehension and confusion which, in turn, reduced the effectiveness of the SA-2/AAA systems. 83/

#### XI. THE TOLL ON WILD WEASEL RESOURCES

Nullifying the SA-2 threat was admittedly the key to retaining air effectiveness in the north, and the WILD WEASEL was the key to destroying the SA-2, but the cost was high. Within a period of less than two months in July and August, five WILD WEASEL aircraft were lost and two

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were so seriously battle damaged as to be unflyable. <sup>84/</sup> CINCPACAF felt the situation in northern North Vietnam was so critical that he requested full emergency action to acquire at least ten additional WILD WEASEL aircraft at the earliest possible date. By early September WILD WEASEL assets were down to four operable aircraft which, even with judicious scheduling, could provide only partial protection to the strike forces, especially in RP's V and VI. CINCPACAF stressed that WILD WEASEL aircraft were an integral part of tactics against the SA-2's, and since the SAM's gave North Vietnam a fully integrated defensive system, USAF had to counteract them or face the danger of losing air superiority in that area. <sup>85/</sup> CINCPACAF foresaw the possibility that the attrition rate on WW aircraft could continue at the same level and, if so, the planned replacement schedule would only compensate for losses, without building up to a level where the hunter-killer teams could get ahead of the game. He also pointed out that if WW IV (F4C) assets did not become rapidly available all WILD WEASEL operations in the near future would have to be conducted with F-105's. The attrition rate for this type aircraft would likely remain <sup>86/</sup> much higher than if the F4C shared the load.

WILD WEASEL/IRON HAND aircraft were performing, perhaps, the most hazardous day-to-day operations of the war; the outlook for more favorable attrition rates was not bright. These aircraft and crews were purposely seeking out the most heavily defended areas in North Vietnam, spending longer periods of time in non-permissive envelopes, literally performing "recon-by-exposure" in what has been called the "most dense

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ground-fire base in history." The WILD WEASEL/IRON HAND teams preceded strike forces into target areas, covered for them during strikes, covered for them as the strike missions withdrew, and then were the last to leave. A study on aircraft losses prepared for the Joint Chiefs in September 1966 reported: <sup>87/</sup>

"...Many of the pilots flying missions in North Vietnam state that we have reached the limit of aircraft and pilot maneuvering capability to avoid the enemy weapons.

"On that basis, the pilots were unanimous and vehement that to reduce losses 'We must tear holes in the enemy's defenses. We must attack the system rather than ignore it.' They say that, given adequate support, we can do this - including rolling back the SAM's. am

"...Of course, their basic premise is that this kind of campaign against the defenses requires, first of all, an adequate stock of the proper kinds of weapons to do the job, in a properly planned campaign. What they call the proper kind of weapons for this is CBU-24, 2,000 and 3,000 pound bombs with improved VT fuzes, 2.75 inch rockets with the 151 head, Shrikes including a proportion with the marking head, and napalm."

In regard to these, with the exception of napalm, the study admitted U.S. stocks of these types of ordnance were critically low. <sup>88/</sup> Napalm itself was not a favored ordnance for operations in North Vietnam since it required too low a delivery mode and exposed the aircraft to every caliber weapon in the NVN inventory. <sup>89/</sup> CBU-24 was a highly desirable ordnance, lauded by pilots for its flak suppression capability and its ease of delivery. Stocks were low through the summer of 1966, but were building slowly as autumn approached. The CBU-24 was a cluster

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bomb unit that was dispensed, not by tube delivery which necessitated low altitudes (50 to 500 feet), but by a canister which could be dropped in the dive mode from normal dive bomb release altitudes of four to six thousand feet. The SUU-30B canister, dispenser element of the CBU-24, carried 665 BLU-26B bomblets loaded at the arsenal. These bomblets, about the size of a tennis ball, had only a fifth of a pound of high explosive but were studded with many little steel balls. They were armed through a spinning action imparted after dispensing and dispersed into an elongated oval pattern approximately one half as wide as the canister-opening altitude. Since coverage was excellent and the bomblets had very few duds the CBU-24 was an excellent anti-personnel and flak suppression weapon. <sup>90/</sup> (With later modification to include a staggered time delay feature of up to 120 minutes, the CBU-24 became the CBU-29. This greatly added to its area-denial and anti-personnel capability. It began to arrive in-theater in early November, 1966, in small numbers.) <sup>91/</sup>

The Shrike missile also underwent modifications to upgrade its capabilities in the hunter-killer role. A 25 June SEAOR (Southeast Asia Operational Requirement) was established which spelled out the desired capabilities for an anti-radiation missile against, primarily, the SAM installations. <sup>92/</sup> Ideally, the missile should have the capability to detect and home in on minimum radar emissions (dummy load), and also have as close to absolute selectivity as technically possible, to solve the ambiguity problem. After lock-on and launch at a particular radar, all other emissions should be blocked out. Also, if a radar went off

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the air after launch, the missile should incorporate a memory circuit order to strike the last computed position of the SAM radar. A better stand-off range was desired, up to 70 nautical miles for a supersonic launch, in order to give the crews a better survival factor and, for the same reason, as fast a missile speed as possible. Time from launch to impact should be short enough to give the pilot a chance to out-duel a SAM installation. A marking capability was considered necessary, and the seeker should contain all three (S, X and C band) frequencies. <sup>93/</sup> Modifications to the existing Shrike while not meeting all these requirements, could improve its performance greatly.

Chief of Naval Operations on 12 August directed accelerated development toward increasing seeker effectiveness of the Shrike so that it could cover a broader spectrum of radar emissions. <sup>94/</sup> Specifically, the AGM-45A-6 would cover the X band (8,000-10,000MC), the AGM-45A-7 from 700-900 or 800-1,000MC to cover FLAT FACE radar and would also lay across the L-band SAM guidance radar. The feasibility of incorporating a low frequency seeker, 70 to 160 MC, which would cover the Spoon Rest acquisition radar, was under study. <sup>95/</sup> This would be the AGM-45A-8.

This high level of interest in the electronic aspects of the air war over North Vietnam illustrated the concerted effort of military planners to maintain air superiority and operational effectiveness under rule of political constraint which prescribed specific parameters of tactics and strategy.

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XII. EFFECTS OF CONSTRAINTS ON THE AIR WAR

The restraints to military air operations over the north were numerous and, in the operational sense, restrictive. In efforts to spare non-combatants, villages and cities were largely untouchable regardless of military activities noted there. Hanoi had a 30 mile "do-not-enter" ring around it; Haiphong a ten mile free zone. West of 106° there was a 30 mile deep buffer zone, and east of 106° a 25 mile buffer fronting the Chicom border. Haiphong harbor was sacrosanct and, until 29 Jun 1966, <sup>so were</sup> all major POL storage facilities. The Thai Nguyen Steel Plant and other lucrative targets, among them the Hanoi airfield, were off-limits to strike pilots. In addition, the "bombing pauses" of five days from 13-18 May 1965, and 37 days from 24 December to 31 January 1966, allowed Hanoi the luxury of unopposed building and expansion of their air-defense structure. *all*

The buffer zones and sanctuaries were readily apparent to the enemy and the communists took full military advantage of it. The buffer zone alone, for instance, gave Hanoi thousands of square miles of territory they did not need to defend. This allowed them to concentrate AW/AAA and SAM in a far smaller area, increasing their ground fire base tremendously. At the same time, the buffer zone reduced U.S. strike pilots' flexibility by funneling ingress and egress routes into narrower, more predictable channels where the enemy could further concentrate his defense forces. Stereotyped operations, sanctuaries and pauses all accrued to the enemy's benefit. The U.S. concept of gradually increasing pressure

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allotted Hanoi one final valuable factor, time - time to fully integrate the North Vietnamese defense structure, with the SAM as the key.

Practically all top military leaders in the Pacific were in accord on this score. In preparation for the upcoming SA-2 Threat Conference of 17 October 1966, CINCPACFLT noted: <sup>96/</sup>

"...Early in the air operations over NVN, the enemy's defenses were weak and limited. Now, after having given NVN the incentive, access to the required weapons and, most important, time to build the defenses, PACOM forces are confronted with a dense array of weapons and an integrated defense that is controlled centrally."

CINCPACAF, on 15 October, brought out much the same line of thought: <sup>97/</sup>

"...In the case of the SA-2, restrictions, sanctuaries, and our U.S. concept of slow, steadily increasing pressure, allowed the enemy sufficient opportunity to build his defense without effective interference. He has been able to camouflage, and disperse components to an extremely successful degree."

It could not be gainsaid that North Vietnamese defenses, both quantitatively and qualitatively, had gone through an amazing growth in 24 months. From the Tonkin Gulf incident in August of 1964 through August of 1966, some significant developments are noted: <sup>98/</sup>

DEVELOPMENTS IN NORTH VIETNAM DEFENSES

July 1964      Air Defense System Based Upon Obsolescent Equipment:

Fighter Aircraft	- 0	Radars	- 24
SAMs	- 0	AAA	510

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Aug 1964 Introduction of Jet Aircraft (MIG-15).

Jan 1965 Two-fold Increase in Radar Inventory (41).

Mar 1965 Introduction of Improved Radar (GCI, HF).

Apr 1965 First Employment of Fighter Aircraft (MIG-17).  
First SAM Site under Construction.

Jul 1965 First SAM Fired at U.S. Aircraft. Introduction  
of 100mm AAA Weapons.

Aug 1965 Significant Increase in Low-Altitude Radar  
Coverage. Six-Fold Increase in AAA Weapons  
(3,000).

Dec 1965 Introduction of MIG-21.

Jan 1966<sup>b</sup> Emission Control of Radar Commences.

Mar 1966<sup>b</sup> Introduction of Soviet IFF Systems (Effective  
GCI Control of Fighter Forces).

Aug 1966 Sophisticated Air Defense System:

Fighters - 65	Radars - 271
SAMs (20 - 25 Battalions)	AAA - 4,400

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This buildup of the North Vietnamese defensive posture had been foreseen by 2nd Air Division planners earlier, as shown by a 2nd Air Division request for a broader target base and more latitude in strike planning. <sup>99/</sup> Second Air Division felt that all POL storage facilities and some selected power plants should be considered as prime continuing targets in North Vietnam. Further, 2nd Air Division felt that it was necessary to remove the restrictions which applied to dams and locks in order to permit interdiction of waterway LOC's by lowering navigable water levels. One high priority target, the 2nd Air Division pointed out, was the Kep EW/GCI complex. This they wanted neutralized immediately. Analysis of the

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then current enemy air defense system showed they were employing an increasingly sophisticated early warning system which was beginning to integrate its many elements. The Commander, 2nd Air Division, felt strongly that the U.S. should not stand by to see the development of a fully integrated and operational air-missile-AAA defense system in North Vietnam. Such a development would pose an unacceptable threat to strike forces and would also mean that continued air operations under such an environment could be carried out only at a considerable increase in cost. He, therefore, recommended that he be granted immediate authority to strike all airfields in North Vietnam which were capable of jet operations, and that IRON HAND forces be authorized to destroy all the SA-2 sites that posed a threat to, or fired upon, U.S. aircraft striking any 100/ of the aforementioned targets.

The SAM's, however, were allowed to proliferate and the other elements of air defense were permitted to coalesce until CINCPAC asked 101/ his commanders for their views. He said:

"It is appropriate at this time to review all aspects of the SA-2 threat. The objective of the review is to determine what can be done with what is available now to counter the threat, what additional equipment is required to enhance our ability to cope with the SA-2, and what is required should the threat become more sophisticated and/or increase in scope. The ultimate objective is to eliminate the threat or degrade it to the extent that aircraft can operate at optimum altitudes and employ optimum tactics.

"...It is recognized that much has been done and is being done to counter the threat, modification of aircraft with new equipment is continuing. Numbers and sophistication of support aircraft is improving.

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Weapons and modifications to weapons are being introduced that can better destroy the SA-2 and associated equipment. Most significant of all are the skillful tactics which pilots have developed to avoid the missiles. The improved equipment and improved tactics have not, however, overcome the missile's main accomplishment, i.e., forcing aircraft to operate at lethal ground fire altitudes and degrading strike tactics to a serious degree."

CINCPAC asked for recommendations in detail from his commanders, by which the U.S. anti-SAM posture could be improved, both long and short term. He requested that action on this subject be given high 102/ priority.

XIII. THE QRC-160A-1 ECM POD

Several high priority actions had already been carried out, one of which showed promise of greatly suppressing - if not ending - SA-2 domination of the mid-altitudes. Seventh Air Force OPLAN 461-67, dated 16 September 1966, directed an evaluation of the QRC-160-1 electronic countermeasure pod under combat conditions. The test was carried out on actual missions over North Vietnam from 26 Sep 1966 to 8 October 1966, 103/ and the final results were highly encouraging. The QRC-160 ECM pods were airborne radar-jammers preset on the ground to counter the most serious, or most likely, threat - in this case the S-band spectrums of the Fan Song and Fire Can radar. For purposes of the test, F-105 aircraft were equipped with one QRC-160A-1 pod on each outboard wing station.

The 355th Tactical Fighter Wing at Takhli, under the direction of Colonel Robert R. Scott (former commander of the 6002nd Stan/Eval Group, publishers of PACAF Tactics/Techniques Bulletin) was

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designated to conduct the test. This evaluation was to test the effectiveness of the pod to prevent accurate radar tracking and firing of anti-aircraft artillery and surface-to-air missiles and, equally important, to determine the reliability and maintainability of the QRC-160. <sup>104/</sup>

The test missions were flown over heavily defended target areas, hand-picked to provide a dense radar environment in the Fan Song/Fire Can spectrums controlling 85mm and 100mm AAA and SA-2 missiles. EB-66C aircraft accompanied the flights and made airborne checks of each pod's effectiveness, and in the meantime collected data on the reaction of the enemy radars to the pod jammers. During the early missions the EB-66C's refrained from jamming signals covered by the pods, but later missions required them to provide stand-off jamming along with the pod-equipped fighters because of a mixed strike force, i.e., some strike aircraft were not jammer-equipped.

Test results through the entire period of the evaluation appeared to show that it was tactically an unequivocal success. Only on two occasions was AAA observed in 19 missions. Of these, one was pure barrage type 37mm (non-radar controlled) in the Yen Bay area, on the Red River. The other was near Hanoi and consisted of 37mm, 57mm and radar-directed 85mm. Only one SAM firing was noted; this was directed at a non-jamming aircraft in distress in the Hanoi area. The last day of the evaluation, 8 October, was noteworthy in that it provided a "tour de force" demonstration of the capabilities of the equipment and tactics, and during the same day showed the vulnerabilities of non-jamming aircraft

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in this environment.

The 8 October mission was a flak-suppression mission flown into an extremely high threat environment over JCS 51, the Nguyen Khe POL area. The mission consisted of three flights (Taksan, Drill and Steel) of four aircraft each. Each aircraft carried two QRC-160 pods for radar suppression. The number two aircraft in Taksan flight, first flight into the target, had aborted and was replaced by a non-pod carrying spare. As the flight entered the target area it split into two elements composed of Taksan 1 and 2, and Taksan 3 and 4. Taksan 1's ECM pods failed to operate so this element had no jamming capability. In the target area a MIG-21 slipped in between Taksan 1 and 2 and went into pursuit of the lead aircraft. While attempting to lose the MIG, Taksan 1 was fired upon by radar directed 85mm AAA; three rounds exploded close enough to inflict battle damage on the F-105. After jettisoning his stores (except for ECM pods) and evading the MIG, Taksan 1 experienced a flame-out. He zoomed to 10,000 feet and restarted his engine, but then observed an SA-2 being launched against him. To evade the missile he dove to 2,000 feet and watched the SAM pass 200 yards over and in front of his aircraft, then climbed above 4,000 feet to get away from the 37mm and 57mm AAA and the radar-controlled 85mm but did not take any hits. Taksan 3 and 4 had all their pods functioning well; they reported light 37mm and 57mm optically sighted AAA but were not hit. 106/

Drill flight's tactics brought them into the target area at 2,000 feet where they reported barrage 37mm and 57mm. As they approached

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their target Drill executed a pop-up to 13,000 and rolled into a dive-run. The flight left the target at 4,500 feet, reporting light 37/57mm below them, but no radar-directed AAA or SA-2's. 107/

It was the third flight, Steel, that put the pod concept to its most severe test and in doing so executed what could only be called a true "tour de force". Led by Major Douglas D. Bremner, Steel flight entered the target area at an altitude tantamount to suicide in the SA-2 environment, with Lead at 13,000 feet and the others staggered up to 16,000 feet. The flight remained straight and level on the run-in to the target, which allowed them ample time for target acquisition and line-up for their dive runs. After delivering their ordnance the members of the flight reformed with Lead at 17,000 feet and left the target. Steel flight reported no sighting of 85mm AAA or SAM's during their run-in, delivery or egress, although the EB-66C's reported that six Fan Song sites in the target area were active during the mission. ELINT collected during the mission showed that 12 Fan Song and 16 Fire Can signals were received but the only radar-controlled AAA and the only SA-2 launched were directed at an aircraft whose QRC-160 was not functioning. 108/

The results as outlined in the evaluation report showed that non-pod-equipped aircraft were subjected to 37mm and 57mm barrage AAA, radar-directed 85mm AAA and a radar-controlled SA-2 firing. Those pod-equipped aircraft which entered the target area at a low altitude experienced barrage 37/57mm AAA but were not threatened by radar-directed defenses. High flying pod-equipped aircraft, spaced in good tactical formation, did not experience any 37mm, 57mm, radar-controlled AAA or

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missile firings, although they purposely presented themselves as a straight and level non-evasive target at 85mm and SA-2 point-black<sup>n</sup> altitude. 109/

The report's conclusions added: 110/

"(1) The QRC-160-1 is an effective countermeasure against Fire Can controlled AAA and the SA-2 A and B.

"(2) Tactics used in this evaluation with respect to formation, altitude, spacing, etc., are sound.

"(3) Operation at medium altitudes in SA-2 and Fire Can Environment is feasible for pod-equipped aircraft in loose formation."

The tactical formation determined through the evaluation as being optimum was a very loose fingertip with Lead's wingman out 1,500 to 2,000 feet from Lead, and 500 to 1,000 feet above him. On the other side, the second element was spaced back and out 2,000 to 3,000 feet and similarly stepped up 1,000 to 2,000 feet. In addition to being easily flown and allowing wing and element pilots to direct their attention downward in keeping with the mission requirements, the formation provided optimum interaction of the jammers. When all four aircraft were jamming, the Fan Song or Fire Can operator was forced to choose from 16 possible targets of which only four were actually aircraft. 111/

Because of drag considerations, fuel consumption for 'pod-equipped airplanes was increased by three to four percent. This made bingo fuel requirements approximately 500 pounds greater than for non-pod equipped. It would appear this disadvantage was more than compensated by

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fuel saved from not having to engage in violent evasive actions at low altitudes. One deficiency apparent was that the QRC-160 equipment was not compatible with RHAW. The ECM pods jammed the radar homing equipment as effectively as it jammed the S-band radar itself. <sup>112/</sup>

All in all, however, the evaluation proved a great step forward in counter-SAM tactics. At no time during the test were any jamming aircraft in formation tracked and fired upon by radar-directed SA-2's or AAA. <sup>113/</sup>

At the time of the test, 24 of the 92 QRC-160 pods in the Air Force inventory were available for evaluation. By early November there were 55 of these pods at Takhli and Korat. Seventh Air Force made every effort to frag at least three out of four aircraft in each strike flight with the jammers. <sup>114/</sup> In November 1966, with the operation of the QRC-160A-1 still in an early stage, a flat prediction of its continued success might be unwarranted. In the see-saw struggle of offense-defense it was to be assumed that the enemy would attempt to develop rapidly some countermeasure to the ECM pod. (The VAMPYRUS Report recommended procuring the C-band canister for use in the QRC-160 in anticipation of North Vietnam acquiring the SA-2C missile.) In the meantime, however, the S-band jammers appeared to have opened up the medium altitude to our fighters for the first time in over a year. The benefits were manifold. Avoidance of battle damage or loss by exposure to the AW/AAA envelope at low altitudes was, perhaps, of most importance. However, the return to optimum strike tactics, "leisurely" target acquisition, accurate line up for ordnance delivery -

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instead of the hurried few seconds allotted in the pop-up attack - presaged great gains in many respects. Less ordnance expenditure for probable target destruction could be expected, based upon smaller CEP's and more accurate target identification. More aircraft could be assigned to the primary job of target destruction, instead of fragmenting strike forces into pure flak suppression, if the organic ECM capability retained its initial superiority.

Many other spin-outs accrued. Navigation was greatly simplified which, in turn, further simplified target acquisition. All-weather MSQ-77 (Skyspot) bombing in the lower route packages became at least a possibility which could allow a continuous weight of effort during the northeast monsoon instead of off-again on-again strikes. This possibility was under consideration. <sup>115/</sup> Also considered was the possibility of configuring some of the WILD WEASEL/IRON HAND aircraft with the QRC-160A-1 in such a way as to provide mutual coverage of aircraft without degrading the basic weapons systems used by the hunter killers. These and other tactics and equipment modifications were being closely looked at by Commander, 7th Air Force, and his staff; the go-ahead on many of these was dependent <sup>116/</sup> only upon the arrival of more pods in-theater.

Following the <sup>0</sup>initial evaluation of the QRC-160A-1, little time was spent incorporating it into daily mission frag orders. Because of the relative paucity of the jammers (approximately 30 at Takhli and 25 at Korat) <sup>117/</sup> tactics evolved using them on only three of four aircraft in a flight. It was found that if the lead aircraft and the outside

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aircraft were equipped with pods a degree of mutual protection was afforded the entire flight. <sup>118/</sup> In addition, the non-podded aircraft could use the Vector APR 25/26 to monitor the radar environment. <sup>119/</sup>

As operations continued through October and November, praise for the concept from both pilots and the commanders mounted. In a letter from the commander of the 388th Tactical Fighter Wing to 7th Air Force Director of Operations, Colonel William S. Chairsell said: <sup>120/</sup>

"The introduction of the QRC-160A-1 pod to the F-105 weapons represents one of the most effective operational innovations I have ever encountered. Seldom has a technological advance of this nature so degraded the enemy's defense posture. It has literally transformed the hostile air defense environment we once faced, to one in which we can now operate with a latitude of permissibility."

Op-4 reports from the pilots themselves abundantly backed up this view. On 4 November Hornet flight, a flight of four F-105's (three were pod-equipped) observed at least nine and possibly 11 SA-2's launched at them in the vicinity of 2115N/10630E. None of the SAM's appeared to guide. The closest detonated 3/4 of a mile away. It was significant that this flight flew straight and level through its entire penetration and withdrawal. Equally significant was that a WILD WEASEL aircraft, Machete 1, ten miles away and without pods, was downed by the first of three SAM's fired at it. <sup>121/</sup>

Other Op-4's showed very little radar tracking of pod-equipped aircraft. Most indicated "none" or "light inaccurate barrage" (non-radar).

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As far as could be determined, no "Quirk" equipped F-105's (pods operating) have been lost to radar directed gunfire or SA-2's from the first day of use through 25 November 1966. <sup>122/</sup>

Under high level logistics priority, more - and improved - ECM jammers were programmed into Southeast Asia. Five QRC-160A-1/ALQ-71 pods were scheduled for December 1966, building to 21 in March 1967, and a total of 200-plus by October 1967. <sup>123/</sup> (This, in addition to 50 early QRC-160-1's in OCAMA for modification.) Other hoped-for arrivals included the QRC-160-8, C-band "quiet jammers," silent until "spoken to", and the fully automatic QRC-288 which would counter radar threats in the C, S, L and X bands, almost all of NVN's radar spectrum. <sup>124/</sup>

#### XIV. ONE STEP AHEAD

It would be a valid assumption that North Vietnam planners (indeed the entire Communist bloc) were burning midnight candles to find ways of countering this serious degradation of their air defense capability. After an extended period of SA-2 domination of the medium altitudes, U.S. aircraft were once again able to operate effectively and economically in this critical area. It was certain that, temporarily if not permanently, the United States had gone from one step behind to one step ahead in the unending battle of tactics and techniques.

No one, least of all LtGen William W. Momyer, Commander, 7th Air Force, was ready to discard those proven combat tactics so painstakingly learned. Other "breakthroughs" were diligently sought; real-time

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readout of intelligence data, pinpoint all-weather navigation and strike capability, improved weapons and weapons systems, the ability to degrade or even to use the enemy's far flung and sophisticated electronics net. Definitive answers to many of these were almost operational realities; others required more effort and still others were in the planning stages.

XV. THE OUTLOOK

Few realistic thinkers felt the air war over North Vietnam had already been won. North Vietnam retained a formidable capability of air defense, but the outlook as 1967 approached was far brighter than it had been since July 1965. Perhaps the one brightest spot was the demonstrated success of the QRC-160A-1 and the added capabilities envisioned in its successors. The improved Shrike was due in-theater which would enhance SAM destruction along with radar suppression. Improved ordnance was helping improve strike profiles; the CBU-24 released pilots from the "on-the-deck" delivery required by the earlier CBU family, and the CBU-29 added a significant area denial capability. The impending arrival of the F4E promised a gun capability, alleviating the narrow strictures of missile launch and allowing pilots to close with the enemy in air-to-air combat. Increased logistics alone helped improve combat tactics through optimum ordnance mixes and addition of new and reliable equipment. Finally, the inventory of experience built up by U.S. pilots and planners since the first raids of February 1965 also promised to influence the employment of effective air tactics in future operations.

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APPENDIX 1

SCOREBOARD - U.S. AIRCRAFT vs NVN DEFENSES

U.S. TOTAL LOSSES - ALL DEFENSES

(1 Jan 65 - 31 Oct 66 by Rt Pkg)

ROUTE PACKAGE

Lost To:	I	II	III	IV	V	VIA	VIB
Ground Fire (Undetermined)	4		2	2			2
AW	25	12	17	14	15	7	6
Light AAA	40	20	27	20	14	18	33
Med AAA				2		9	3
Heavy AAA							
SAM		4	2	5	2	7	7
Fighters*				3	2		3
Unknown**	13	5	20	9	8	3	4
TOTAL	82	41	68	55	41	44	58

\* A ninth acft (Navy KA3B) was assumed downed by CHICOM MIG's off the coast of Hainan. A total of five aircraft were lost to NVN surface fire (AW and small arms) over the Gulf of Tonkin.

\*\* "Unknown" losses were assumed to be the result of enemy action. Known operational losses (materiel failure, wx, etc.) totaled 14, and were not credited to enemy defenses.

LOSSES by CAUSE (Incl Tonkin Gulf and Hainan)

GROUND FIRE: 297

SAM: 27

MIG: 9

UNKNOWN: 62

NVN TOTAL: 395

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SAM LOSS CHRONOLOGY  
(24 July, 1965 - 31 October 1966)

<u>ROUTE</u> <u>PKG</u>	<u>DATE</u>	<u>MISSION</u>	<u>ALT</u>	<u>TYPE</u> <u>ACFT</u>	<u>CALL</u> <u>SIGN</u>	<u>ORG</u>	<u>ACFT</u> <u>TACTIC</u>
V	24 Jul 65	Strike	23M	F4C	Leopard 2	45 TFS	S & L
IV	12 Aug 65	Arm/Recce	9M	A4E	Lawcase 345	Midway	
IV	24 Aug 65	Strike	12M	F4B	Sundown 112	Midway	
IV	30 Sep 65	Strike	18M	F-105	Mercury 1	23 TFW	
VIB	5 Oct 65	Arm/Recce	31M	F8E	Superheat	Oriskany	
IV	27 Oct 65	Unk	3.2M	F8E	Feedbag 105	Bon Homme Richard	
IV	5 Nov 65	IH	6.5M	F-105	Oak 1	388 TFW	
VIB	16 Nov 65	IH	4M	F-105	Oak 4	388 TFW	
V	19 Dec 65	Unk	20M	F4C	Grizzley 2		
VIB	22 Dec 65	Strike	2M	RA5C	Flint River	Kitty Hawk	
III	9 Feb 66	Arm/Recce	4.5M	A4C	Warpaint 546	Ticonderoga	
III	25 Feb 66	ELINT	28M	RB-66C	Gull I	41 TRW	Level turn
II	21 Mar 66	Arm/Recce	1M	A4C	Hoboken 411	Enterprise	
II	21 Mar 66	Arm/Recce	1M	A4C	Hoboken 406	Enterprise	
II	13 Apr 66	Arm/Recce	7.5M	A1H	Viceroy 381	Ticonderoga	Level turn
VIA	24 Apr 66	Strike	6M	F-105	Oak 1	388 TFW	
VIB	19 Jul 66	Strike	6M	F8E	Superheat 3	Oriskany	
VIA	20 Jul 66	ELINT	29M	EB-66C	Devil 1	41st TRW	Jinking
VIA	23 Jul 66	IH	3-4M	F-105F	Drill 1	355 TFW	Jinking
VIA	1 Aug 66	IH	5M	F-104	Flip 1	435 TFW	
VIA	1 Aug 66	IH	4M	F-104	Dagger 2	435 TFW	
VIA	7 Aug 66	Arm/Recce	10M	F-105	Atlanta 1	355 TFW	Jinking

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SAM Loss Chronology (Continued)

<u>ROUTE</u> <u>PKG</u>	<u>DATE</u>	<u>MISSION</u>	<u>ALT</u>	<u>TYPE</u> <u>ACFT</u>	<u>CALL</u> <u>SIGN</u>	<u>ORG</u>	<u>ACFT</u> <u>TACTIC</u>
VIB	7 Aug 66	IH	13M	F-105F	Mombo 1	355 TFW	Jinking
VIA	4 Sep 66	Strike	2M	F4C	Satan 3	8 TFW	Level turn
VIB	10 Sep 66	Strike	4.5M	F4C	Clipper 1	8 TFW	Level turn
II	14 Sep 66	Arm/Recce	1.3M	A1H	Canasta 580	Coral Sea	Jinking
VIB	19 Sep 66	Strike	5M	F-105	Hornet 2	388 TFW	Level turn

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MIGS DOWNED BY USAF AIRCRAFT

<u>DATE</u>	<u>CREW</u>	<u>AIRCRAFT-WEAPON</u>	<u>LOCATION</u>	<u>ORGN</u>
10 Jul 65	Capt Kenneth E Holcombe Capt Arthur C Clark	MIG-17 - F4C by Sidewinder	65 mi NW Hanoi	45 TFS
10 Jul 65	Capt Thomas S Roberts Capt Ronald C Anderson	MIG-17 - F4C by Sidewinder	65 mi NW Hanoi	45 TFS
23 Apr 66	Capt Robert E Blake 1/Lt S. W. George	MIG-17 - F4C by Sparrow	65 mi N Hanoi	555TFS
23 Apr 66	Capt Max Cameron 1/Lt Robert E Evans	MIG-17 - F4C by Sidewinder	65 mi N Hanoi	555TFS
26 Apr 66	Maj Paul J Gilmore 1/Lt William T Smith	MIG-21 - F4C by Sidewinder	65 mi NNW Hanoi	480TFS
29 Apr 66	Capt William D Dowell 1/Lt Halbert E Gossard	MIG-17 - F4C by Sidewinder	55 mi NNE Hanoi	555TFS
29 Apr 66	Capt Larry R Keith 1/Lt Robert A Bleakley	MIG-17 - F4C Crashed evading	55 mi NNE Hanoi	555TFS
30 Apr 66	Capt Lawrence H Goldberg 1/Lt Gerald D Hardgrave	MIG-17 - F4C by Sidewinder	100 mi WNW Hanoi	555TFS
12 May 66	Maj Wilbur R Dudley 1/Lt Imantes Kringelis	MIG-17 - F4C by Sidewinder	105 mi NW Hanoi	390TFS
29 Jun 66	Maj Fred L Tracy (Probable kill)	MIG-17 - F-105 by 20mm	25 mi NNW Hanoi	
14 Jul 66	Capt William J Swendner 1/Lt Duane A Buttell	MIG-21 - F4C by Sidewinder	22 mi NW Hanoi	480TFS
14 Jul 66	1/Lt Ronald G Martin 1/Lt Richard N Kriepe	MIG-21 - F4C by Sidewinder	50 mi NW Hanoi	480TFS
18 Aug 66	Maj Kenneth T Blank	MIG-17 - F-105 by 20mm	18 mi N Hanoi	388TFW
16 Sep 66	1/Lt J. W. Jameson 1/Lt D. B. Rose	MIG-17 - F4C by Sidewinder	30 mi ENE Hanoi	8TFW
21 Sep 66	1/Lt Karl W Richter	MIG-17 - F-105 by 20mm	30 mi N Haiphong	388TFW
21 Sep 66	1/Lt Fred A Wilson	MIG-17 - F-105 by 20mm	35 mi ENE Hanoi	355TFW

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MIGS Downed by USAF Aircraft (Continued)

<u>DATE</u>	<u>CREW</u>	<u>AIRCRAFT-WEAPON</u>	<u>LOCATION</u>	<u>ORGN</u>
5 Nov 66	Capt James Tuck 1/Lt John Rabeni	MIG-21 - F4C by Sparrow	83 mi NW Hanoi	480TFW
5 Nov 66	1/Lt Joseph Lathan 1/Lt Klaus Klaue	MIG-21 - F4C by Sidewinder	83 mi NW Hanoi	480TFW

MIGS DOWNED BY USN AIRCRAFT

17 Jun 65	Cdr L. C. Page Lt John C. Smith	MIG-17 - F4B by Sidewinder	55 mi S Hanoi	Midway
17 Jun 65	Lt Jack E D Batson, Jr. LtCmdr Robert B Doremus	MIG-17 - F4B by Sidewinder	55 mi S Hanoi	Midway
20 Jun 65	Lt Clinton B Johnson LtJG Charles W Hartman	MIG-17 - 2 AlH by 20mm	50 mi SSW Hanoi	Coral Sea
12 Jun 66	Cdr Harold L Marr	MIG-17 - F8E by Sidewinder	24 mi Haiphong	Hancock
21 Jun 66	LtJG Philip V Vampatella	MIG-17 - F8E by Sidewinder		Hancock
13 Jul 66	Lt William M McGuigan LtJG Robert M Fowler	MIG-17 - F4B by Sidewinder	NVN coast	Constel- lation
9 Oct 66	Cdr R. M. Bellinger	MIG-21 - F8E by Sidewinder	28 mi SSE Hanoi	
9 Oct 66	LtJG W T Patton	MIG-17 - AlH by 20mm	25 mi S Hanoi	

U.S. AIRCRAFT DOWNED BY MIGS

4 Apr 65	ZINC 1	F-105 - MIG-17 23/37mm	25 mi Thanh Hoa	18TFW
4 Apr 65	ZINC 2	F-105 - MIG-17 23/37mm	25 mi Thanh Hoa	18TFW
12 Apr 66	HOLLY GREEN*	KA3B - Unk MIG Unk	Vic Hainan	Kittyhawk

\*HOLLY GREEN was lost to radar contact in the vicinity of Hainan. The following day the Chicom radio announced the shootdown of the aircraft.

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U.S. Aircraft Downed by MIGS (Continued)

<u>DATE</u>	<u>CREW</u>	<u>AIRCRAFT-WEAPON</u>	<u>LOCATION</u>	<u>ORGN</u>
21 Jun 66	NICKLE 100	F8E - MIG-17 23/37mm	35 mi NE Nanoi	Hancock
11 Jul 66	ANVIL 2	F-105 - MIG-21 Prob AA-2 (Atoll)	65 mi WSW Hanoi	355TFW
14 Jul 66	SUPERHEAT 202	F8E - MIG-17 23/37mm	30 mi SW Hanoi	Oriskany
5 Sep 66	OLD NICK 106	F8E - MIG-17 23/37mm	40 mi S Hanoi	Oriskany
21 Sep 66	SPITFIRE 3	F4C - MIG-17 23/37mm	35 mi ENE Hanoi	8TFW
5 Oct 66	TEMPEST 3	F4C - MIG-21 AA-2 Atoll*	100 mi WNW Hanoi	8TFW

\* Heat-seeking missile almost identical to U.S. AIM-9 Sidewinder.

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